THE TYPES OF *ASTRAGALUS* SECTION *DIPHYSI* (FABACEAE), A COMPLEX ENDEMIC TO WESTERN NORTH AMERICA, PART I: LECTOTYPIFICATIONS, EPITYPIFICATIONS, AND NEW COMBINATIONS OF SEVERAL TAXA

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RESUMEN

This is the first of several papers discussing typification issues found during studies leading to a monograph of *Astragalus* L. Section *Diphysi* A. Gray. A lectotype and an epitype are designated for *A. lentiginosus* Douglas ex Hook. Original material designated here as the holotype of *Astragalus diphysus* A. Gray var. *albiflorus* A. Gray [=*Astragalus lentiginosus* var. *albiflorus* (A. Gray) Schoener] was rediscovered at GH and the status of its priority over the more commonly used name, *A. lentiginosus* var. *diphysus* (A. Gray) M.E. Jones, is discussed. Epitypes are designated for *A. lentiginosus* var. *micans* Barneby and *A. lentiginosus* var. *oropedii* Barneby. Three new combinations, previously recognized as species, are proposed: **A. lentiginosus** var. **bryantii** (Barneby) J.A. Alexander, **A. lentiginosus** var. **iodanthus** (S. Watson) J.A. Alexander, and **A. lentiginosus** var. **pseudiodanthus** (Barneby) J.A. Alexander.

RESUMEN

Este es el primero de varios documentos que discute problemas de tipificación detectados durante los estudios para una monografía de *Astragalus* L. Section *Diphysi* A. Gray. Se designa un lectotipo y epitipo para *A. lentiginosus* Douglas ex Hook. El material original designado aquí como holotipo de *Astragalus diphysus* A. Gray var. *albiflorus* A. Gray [=*Astragalus lentiginosus* var. *albiflorus* (A. Gray) Schoener] fue redescubierto en GH y se discute su prioridad sobre el uso más común del nombre, *A. lentiginosus* var. *diphysus* (A. Gray) M.E. Jones. Son designados epitipos de *A. lentiginosus* var. *micans* Barneby y *A. lentiginosus* var. *oropedii* Barneby. Se proponen tres nuevas combinaciones, previamente reconocidas como especies: **A. lentiginosus** var. **bryantii** (Barneby) J.A. Alexander, **A. lentiginosus** var. **iodanthus** (S. Watson) J.A. Alexander, y **A. lentiginosus** var. **pseudiodanthus** (Barneby) J.A. Alexander.

INTRODUCTION

Astragalus L. Section *Diphysi* A. Gray, a section native to Western North America, is a problematic species complex composed of taxa that were originally described as or have been split as species in the past 150 years. *Astragalus lentiginosus* Douglas ex Hook. (in Hooker 1831) and *A. diphysus* A. Gray (in Gray 1849) were the core species of Section *Diphysi* in the first comprehensive monograph of *Astragalus* by Asa Gray (1863). Sereno Watson (1871) expanded Gray's concept of Section *Diphysi* to include *A. coulteri* Benth. and *A. platytropis* A. Gray, both of which have inflated pods similar to *A. lentiginosus*. Gray's monograph (1863) and Watson's (1871) revision were the primary references for *Astragalus* taxonomy until Marcus E. Jones began publication of treatments in the genus in the late 1890s.

In his 1898 publication, Jones proposed that species from Gray's (1863) Section *Diphysi* should be combined, as varieties, into a greatly expanded concept of *A. lentiginosus*. His full treatment of these species was not widely known until he published his *Revision of North-American Species of Astragalus* in 1923 (Barneby 1964). Jones was a field botanist of unmatched experience. As a taxonomist, he had a disdain for rules of priority and nomenclature, and was known for his often frustrating brevity. Barneby (1945) found "that many of his names covered unreasonable extremes of variation, or that his descriptions and indications of range were either inaccurate or actually misleading" (p.65). Barneby was able to decipher Jones' species only after extensive study of his annotations and vouchers at POM and duplicates at other herbaria (see discussion of *A lancearius* A. Gray and *A. episcopus* S. Watson, Barneby 1964, p. 267; compare descriptions of varieties of *A. lentiginosus* of Jones 1923, p.124–125 and Barneby 1945, p. 65–152; and discussion of the taxonomic

confusion between Jones' species and hybrids which are now synonyms of *A. argophyllus* Nutt. var. *martinii* M.E. Jones, *A. marianus* Barneby, and *A. desereticus* M.E. Jones, Barneby 1964 p.629–635).

Concurrently, Rydberg (1929) delimited all members of Section *Diphysi* as separate species of the genus *Cystium* Steven. Rydberg appeared to have an idealized concept of each of his species. He regularly composed his morphological descriptions and keys from features exclusively on a single type. As a result, his keys and descriptions sometimes did not match the morphology on all specimens he annotated for his monograph. Despite this, Rydberg for his time was more precise than all previous workers in the genus (Barneby 1964).

Barneby (1945) was the first to comprehensively evaluate Jones' and Rydberg's monographs and found that only one overall classification scheme fit the taxa related to *A. lentiginosus* well: the delimitations of all former species into varieties. Barneby's (1945) treatment and his later Monograph (1964) still serve as a precise baseline from which all taxonomic treatments in this group are based.

Different taxonomic interpretations of the degree of morphological differentiation among the many widespread, sympatric, and geographically isolated taxa within this complex have been the major source of disagreement between the revisions of Rydberg (1929), Jones (1923), Barneby (1964, 1989), Isely (1998), and Welsh (2007). Ultimately the major differences in varietal delimitations between these workers stem from their individual interpretation of type specimens and selection of morphological characters representing the nomenclaturally "typical" variant. Despite Barneby's decades of work in sorting out the typification issues leading up to his Monograph, it is still difficult to determine which variant is nomenclaturally "typical" due to the often poor quality of the type material. Barneby compensated for the poor nature of many types by examining specimens from the vicinity of the type locality. The characters found on those specimens became the informal basis for his concept of the nomenclaturally typical variant and the resulting morphological descriptions.

The most recent monographs, Isely (1998) and Welsh (2007), have made significant additions to the knowledge of taxonomic boundaries in this section, but each has added their own entangled varietal delimitations. However, both still use Barneby (1964) as a nomenclatural foundation. For a monograph of the section that is more comprehensive and thorough than Barneby's, nomenclatural issues that have resulted in conflicting varietal delimitations between the major monographs must be resolved. Fortunately, there are more formal processes in use today that seek refine the delimitation of taxa with problematic types. The Linnaean Plant Name Typification Project (<http://www.nhm.ac.uk/research-curation/research /projects/linnaean-typification/>) has been the forerunner in using modern additions to the lectotypification, epitypification and neotypification articles in the International Code (McNeill et al. 2006). Using the procedures and philosophy of Vander Kloet (1989), Turland and Jarvis (1997), and Krings (2008) as models, this treatment is the first a series of papers proposing new combinations, lectotypifications and epitypifications within Section *Diphysi*. Due to the varietal and nomenclatural complexity of Section Diphysi, a series of papers instead of a single, expansive treatment is necessary. The goal is to stabilize and refine the nomenclature in this group, which will enable the creation of a more comprehensive and less problematic taxonomic revision of this morphologically and taxonomically difficult section.

METHODS

Herbarium specimens were examined at UC in December of 1999, GH in August of 2002, and NY in October of 2003. Additional herbarium specimens were obtained on loan from CAS, DS, K, POM, RM, and RSA. In addition to loans, research was conducted from 2002 to 2008 using the following online type specimen databases: Consortium of California Herbaria Specimen Databases (CAS, DS, JEPS, RSA, SD, UC, UCR, UCSB), University and Jepson Herbaria (2008b); Index of Botanical Specimens (GH), Harvard University Herbaria (2008); Type specimens at the Herbaria (JEPS, UC), University and Jepson Herbaria (2008b); Kew Herbarium Catalogue (K), Royal Botanic Gardens, Kew (2008); Tropicos (MO), Missouri Botanical Garden (2008); The C.V. Starr Virtual Herbarium (NY), New York Botanical Garden (2008); Type Specimen Register

(US), United States National Herbarium (2008). Though the International Code of Botanical Nomenclature (McNeill et al. 2006) was the basis for all nomenclatural decisions, many papers resulting from The Linnaean Plant Name Typification Project (<http://www.nhm.ac.uk/research-curation/research /projects/linnaean-typification/>) were examined for examples of specific applications of the Code. Other typification papers, especially those resulting from the various tropical flora projects, were also examined. Turland and Jarvis (1997) and Krings (2008) were most frequently consulted for example typifications. Vander Kloet (1989) was consulted to determine how other Douglas taxa described by Hooker were lectotypified (i.e., *Vaccinium membranaceum* Douglas ex Hook., p.133).

RESULTS

Astragalus lentiginosus Douglas ex Hook., Fl. Bor.-Amer. 1:151. 1831. *Tragacantha lentiginosa* (Douglas ex Hook.) Kuntze, Revisio Gen. Pl. 2:946. 1891. *Phaca lentiginosa* (Douglas ex Hook.) Piper, Contr. U.S. Natl. Herb. 11:368. 1906. *Cystium lentiginosum* (Douglas ex Hook.) Rydb. Bull. Torrey Bot. Club 40:50. 1913. PROTOLOGUE: "subalpine ranges of the Blue Mountains of North West America. Douglas." TYPE: [U.S.A. OREGON]: in the valley of the Blue Mountains near the source of the Wallawallah [Walla Walla] and Utala [Umatilla] Rivers, [no date], *David Douglas s.n.* (LECTOTYPE [first step] designated by Barneby 1964: K; LECTOTYPE [second step], designated here: K 264018!, the smaller, fruiting, single stemmed element on the upper left hand side of the sheet including the fragment envelope mounted to the right); [U.S.A. OREGON]: on the banks of streams on the southern branches of the Columbia [possibly collected at the same locality as the lectotype], [no date], *David Douglas s.n.* (EPITYPE, designated here: K 264945!, the mostly flowering, larger specimen mounted in the center of the sheet).

Notes.—At K, there are three different specimen sheets filed as types of *Astragalus lentiginosus,* and all of them are mounted with specimens of various species of *Astragalus*. It is not immediately clear which fragments of these specimens are part of the Douglas types. As with other Douglas specimens described as new species by Hooker (1831), none of the type specimens have a locality that matches the location mentioned in the protologue and none have collection numbers.

From an examination of the annotations on the three type sheets, Asa Gray in 1868 was the first to annotate the *A. lentiginosus* specimens at K. Gray did not indicate which of the sheets was the type nor did he annotate every sheet, but he was the first to recognize that the central element (K264945) on one of the types was *A. lentiginosus*. However, he did not recognize that the other two elements on this sheet were type material for *A. diaphanus* Douglas ex Hook. After Gray, the delimitation of typical *Astragalus lentiginosus* has largely been based on the morphology of specimens found in the vicinity of the Blue Mountains in Oregon. Since both *A. lentiginosus* var. *salinus* (Howell) Barneby and *A. lentiginosus* var. *platyphyllidius* (Rydb.) Peck can be found in southern Blue Mountains of Oregon, some populations of these taxa have been misinterpreted as typical *A. lentiginosus*. Barneby (1945) was the first since Gray to critically analyze the types of the *A. lentiginosus* complex and refine typical *A. lentiginosus* morphologically. The only Douglas specimen of *A. lentiginosus* he saw for this revision was the fragmentary type at GH. Barneby (1964, p.917) indicated a specimen a K found "near the source of the Wallahwallah and Utala rivers" was the holotype. This is the first step lectotypification of *Astragalus lentiginosus* (McNeill et al. 2006, Article 9.8). Unquestionably, Barneby selected a fruiting specimen at K as the lectotype of *A. lentiginosus* since he knew that Hooker (1831, p.151) indicated that "the flowers of this do not appear to have been seen by Mr. Douglas" and that "floribus - ?" was the only reference to flowers in the diagnosis. However, there are two sheets in fruit from the same individual at K: one from the Herbarium Benthamianum (K 264012) and one from Herbarium Hookerianum (K 264017). It is likely that Barneby chose the specimen from the Hooker Herbarium, however no specimens at K are annotated by him. The individual, K264017, is mounted with a specimen of *A. lentiginosus* var. *lentiginosus* collected by Dr. Lyall (K 264018). After an examination of the diagnosis and all the types of *A. lentiginosus*, the second step lectotypification was made herein to unambiguously specify which sheet, Kew accession number, and elements mounted on the sheet correspond to the lectotype in accordance with McNeill et al. (2006) Article 9.15. The second specimen, K 264012, is an isolectoype of *A. lentiginosus*.

Since the fruit of typical *Astragalus lentiginosus* is not by itself diagnostic, precise taxon delimitation based on the lectotype is not possible. Both fruit type and flower size are diagnostic features that distinguish typical *A. lentiginosus* from other sympatric varieties. *Astragalus lentiginosus* var. *salinus* has small whitish flowers (keel <9 mm) and thin walled, bladdery inflated pods. *Astragalus lentiginosus* var. *platyphyllidius* has

larger whitish flowers (keel 11–15 mm long) and thick walled, curved pods inflated only towards the base. Throughout its range, the fruit of *A. lentiginosus* var. *lentiginosus* can take both of these forms. The lectotype is a late season specimen with only mature, thick walled, curved pods inflated only at the base. The size of the flowers is unknown.

For a precise interpretation of nomenclaturally typical *Astragalus lentiginosus*, a flowering specimen was chosen from the original Douglas specimens. The epitype of *Astragalus lentiginosus* is designated herein (K264945; McNeill et al. 2006, Article 9.7) as the larger individual (keels 8–9 mm long) in the center of the sheet. It is mounted with two other fragmentary elements. Element 2 (K264015) is a fruiting specimen of *A. diaphanus*. Element three is mounted in two different places on the sheet, has received different accession numbers (K264016 and K264014), and is a flowering specimen of *A. diaphanus*. This entire sheet was from the Herbarium Hookerianum. Elements two and three are potential lectotypes or isolectotypes of *A. diaphanus* and will be discussed in a future publication (Alexander, in prep). The Douglas label is associated with a portion of element three and indicates it was collected "on the banks of streams on the southern branches of the Columbia." Presumably, the flowering *A. lentiginosus* element was collected at the same locality as the *A. diaphanus* elements. Alternatively, the epitype and the lectotype could have been collected from the same geographical vicinity since the Walla Walla and Umatilla Rivers are two of several southern branches of the Columbia River in northeastern Oregon.

Astragalus diphysus var. **albiflorus** A. Gray, Pl. Fendler. Novo-Mexicanae, Mem. Amer. Acad. Arts II. 4:34. 1849. *Astragalus lentiginosus* var. *albiflorus* (A. Gray) Schoener, Great Basin Naturalist 34:180. 1974. PROTOLOGUE: "with the preceding [*Fendler 146* from "around Santa Fe," New Mexico]. No. 147." TYPE: U.S.A. Plantae Novo-Mexicanae [NEW MEXICO]: [locality not specified on label], 1847, *A. Fendler 147* (HOLOTYPE: GH 112365!; ISOTYPES: GH 58715!, K 264023!, MO).

Notes.—When Barneby (1945) examined the Fendler types of *Astragalus diphysus* at GH, he only found one type specimen of *Astragalus diphysus* var. *albiflorus* A. Gray (*Fendler 147* GH58715). This sheet was part of a collection transferred from the herbarium of the Boston Society of Natural History to GH in 1941. Later, Barneby (1964, p. 940) noted that this specimen "was received long after Gray's death and not annotated by him," and selected an isotype at MO as the lectotype. Although not explicitly stated, Barneby may have chosen the MO sheet because GH58715 has an uncertain history and was mounted with an isotype of *Astragalus diphysus* var. *diphysus* (*Fendler 146* GH58716).

In this study, comparisons of GH types and duplicates distributed by Gray to other institutions revealed that Gray distributed specimens and preprinted labels with only a handwritten collector's number. After Gray published his manuscript, *Plantae Fendlerianae Novo-Mexicanae*, workers at the other institutions wrote determinations on their duplicates based his manuscript. The Fendler types examined for this study at GH have the determination written in Gray's hand on the original preprinted Plantae Novo-Mexicanae label. In 2002, a thorough search was conducted at GH of all the North American folders and types of *Astragalus*. The original holotype of *A. diphysus* var. *albiflorus* (*Fendler 147* GH112365) with the collection number and the determination written in Gray's hand was rediscovered. This type specimen was recently divided from another *Astragalus* collection and remounted on a new sheet, which is the likely reason that Barneby was not able to find the original type. Currently, GH112365 is mounted with an unaccessioned, non-type specimen of *A. lentiginosus* collected by Bigelow in 1883 in Albuquerque, New Mexico. The rediscovery of the holotype of *A. diphysus* var. *albiflorus* at GH nullifies Barneby's (1964) lectotypification (McNeill et al. 2006, Article 9.17a).

Astragalus lentiginosus var. **diphysus** (A. Gray) M.E. Jones, Proc. Calif. Acad. Sci. II 5:673. 1895. *Astragalus diphysus* A. Gray, Pl. Fendler. Novo-Mexicanae, Mem. Amer. Acad. Arts II. 4:34. 1849. *Tragacantha diphysa* (A. Gray) Kuntze, Revisio Gen. Pl. 2:944. 1891. *Cystium diphysum* (A. Gray) Rydb. Bull. Torrey Bot. Club 32:659. 1905. PROTOLOGUE: "around Santa Fe [New Mexico]...No. 146." TYPE: U.S.A. Plantae Novo-Mexicanae [NEW MEXICO]: [locality not specified on label], 1847, *A. Fendler 146* (HOLOTYPE: GH 58714!; ISOTYPES: BM, F, GH 58716!, K! [3 Sheets], MO, NY!, P).

Notes.—The valid name for what has been commonly known as *Astragalus lentiginosus* var. *diphysus* (A. Gray) M.E. Jones has been controversial due to conflicting interpretations of prior editions the International Code. Barneby (1964, p. 941) stated "strict adherence to the Rules of Nomenclature require that the earlier in the varietal rank [in his opinion *A. diphysus* var. *albiflorus*] takes precedence [over *A. diphysus* var. *diphysus*]." He rejected making a new combination, *A. lentiginosus* var. *albiflorus*, since it would result in "an absurdity and runs counter to common sense" of using the commonly recognized name. Based on her interpretation of the Article 11 of the 1972 edition of the International Code, Schoener (1974) concluded, "the name, var. *diphysus*, is anteceded by the name *A. diphysus* var. *albiflorus*...[and] the older name in the same rank has precedence" (p. 180). Schoener (1974) then made the new combination, *A. lentiginosus* var. *albiflorus* (A. Gray) Schoener. Some revisions (Welsh 1978; Isely 1998) have recognized Schoener's combination, while the most recent (Welsh 2007) has used Jones'. The most recent International Code (McNeill et al. 2006, Article 11.6 and 26.3) resolves this controversy. Two taxa were described by Gray (1849): first, *A. diphysus* (based on *Fendler 146*); and

second, *A. diphysus* var. *albiflorus* (based on *Fendler 147*). The later taxon, *A. diphysus* var. *albiflorus*, automatically creates the priorable autonym, *A. diphysus* var. *diphysus*. When both are recognized as synonyms, the combination, *A. lentiginosus* var. *diphysus*, that M.E. Jones made in 1895 has priority over Schoener's 1974 combination, *A. lentiginosus* var. *albiflorus*.

Astragalus lentiginosus var. **bryantii** (Barneby) J.A. Alexander, comb. nov. *Astragalus bryantii* Barneby, Proc. Calif. Acad. Sci. 4, 25:156. 1944. PROTOLOGUE: "ARIZONA: at the head of Phantom Canyon in the Grand Canyon of the Colorado River, Coconino Co., 15 Dec. 1939. Collected by Dr. H.C. Bryant..." TYPE: U.S.A. ARIZONA: [Coconino Co.]: head of Phantom Canyon, in Grand Canyon, 15 Dec 1939, *H.C. Bryant s.n.* (HOLOTYPE: CAS 293940!; ISOTYPE: US 1769041, internet image!).

Notes.—*Astragalus lentiginosus* var. *bryantii* (Barneby) J.A. Alexander has been hypothesized to be related to either *A. lentiginosus* var. *palans* (M.E. Jones) M.E. Jones or *A. lentiginosus* var. *mokiacensis* (A. Gray) M.E. Jones in historical and modern treatments (Barneby 1944, Barneby 1964, Barneby 1989, Isely 1998, Welsh 2007). Welsh et al. (2003) and Welsh (2007) determined that specimens in Utah previously identified as *A. bryantii* Barneby are *A. lentiginosus* var. *palans*. All full list of these putative *A. bryantii* specimens has never been published, but presumably among them are the specimens cited by Barneby (1964) and Welsh (2007): *Gaines 828*, *Gaines 1005*, and *Gaines 1009*, all from NAU. Although these specific specimens were not examined, Alexander (2008) did not find any specimen from Utah previously determined as *A. bryantii* Barneby or *A. lentiginosus* var. *palans* that has the unique pod morphology found in the populations in the Phantom Ranch vicinity of the Grand Canyon. As delimited by Alexander (2008), *A. lentiginosus* var. *bryantii* is confined to the canyon populations along tributaries of the Colorado River upstream and downstream of Phantom Ranch, Coconino Co., Arizona. As far as known, these populations are long-distance disjuncts from that of the nearest population of *A. lentiginosus* var. *palans*. In addition, the carpological variation found in the specimens of *A. lentiginosus* var. *bryantii* is distinct from that of *A. lentiginosus* var. *palans*. However, some pod characters do overlap with the range of variation found in populations of *A. lentiginosus* var. *wilsonii* (Greene) Barneby and *A. lentiginosus* var. *ursinus* (A. Gray) Barneby. Barneby (1944) theorized that this taxon was closely related to *A. lentiginosus* var. *mokiacensis*, a relationship that has been discounted in all modern treatments (Barneby 1989, Isely 1998, Welsh et al. 2003, Welsh 2007). Further investigation of habitat in the canyons of the Colorado River eastward from the nearest populations of *A. lentiginosus* var. *mokiacensis* at Emory Falls (*Clover 6079*, CAS!) and Quartermaster Canyon (*Goodding 15-41*, RM!) may reveal populations of *A. lentiginosus* var. *bryantii* intermediate to *A. lentiginosus* var. *mokiacensis*.

Astragalus lentiginosus var. **iodanthus** (S. Watson) J.A. Alexander, comb. nov. *Astragalus iodanthus* S. Watson, Bot. King. 70. 1871. PROTOLOGUE: "in the foothills of Western Nevada from the Virginia to the West Humboldt Mountains; 4500–6000 feet altitude... [S. Watson] 269." TYPE: U.S.A. NEVADA: [Pershing Co.]: West Humboldt Mountains [Humboldt Range, NE of Lovelock], Jun 1868, *S. Watson 269* [in part] (LECTOTYPE, designated by Barneby 1964:962: US 46909!; ISOLECTOTYPES: GH!, NY!, YU).

Astragalus iodanthus var. *diaphanoides* Barneby, Leafl. W. Bot. 4:50. 1944. TYPE: U.S.A. NEVADA: Washoe Co.: between Reno and Dewey, 10 Jun 1943, *H.D. Ripley & R.C. Barneby 5659* (HOLOTYPE: CAS; ISOTYPE: RSA).

Astragalus iodanthus var. *vipereus* Barneby, Mem. New York Bot. Gard. 13:963. 1964. TYPE: U.S.A. IDAHO: Owyhee Co.: on cobblestone bluffs near Bruneau, 31 May 1945, *H.D. Ripley & R.C. Barneby 6485* (HOLOTYPE: CAS; ISOTYPES: NY!, IDS, RSA).

Notes.—In his taxonomic revision, Alexander (2008) concluded that that there is not a high degree of morphological and molecular differentiation between *A. lentiginosus* var. *palans*, *A. iodanthus* and *A. pseudiodanthus* and continued separation of these taxa as separate species is not supported. The new combinations recommended in Alexander (2008) are made formal herein.

Traditionally, differences in pod morphology have been the basis for the separation of *Astragalus iodanthus* S. Watson and *A. pseudiodanthus* Barneby from *A. lentiginosus*. Both have a deciduous, mostly uniloculate to partially biloculate pod with a septum less than half the width of the locule. This feature does differentiate these two taxa from the varieties of *A. lentiginosus* with bladdery inflated, completely biloculate pods. The contrast appears so great that in other sections of *Astragalus*, these differences have been considered species-level indicators. When these two taxa are merged into the complex folds of *A. lentiginosus*, along with the widespread and morphologically diverse taxa allied with *A. lentiginosus* var. *palans* (some of which were also originally recognized as a species), they form a continuum of variation—morphologically and geographically. In the Mojave and Sonoran Deserts, *A. lentiginosus* var. *mokiacensis* and *A. lentiginosus* var. *maricopae* Barneby form the southern end of the continuum with persistent, mostly straight, tubular, scarcely inflated pods and a septum extending from one-half to slightly over three quarters the width of the locule. In the Colorado Plateau vicinity, *A. lentiginosus* var. *palans*, forms the central and eastern axis of the continuum with deciduous, mostly straight to nearly 180° curved, tubular to triquetrous, scarcely inflated pods and a septum from one-half to slightly over three quarters the width of the locule. In the Great Basin, *A. lentiginosus* var. *iodanthus* (S. Watson) J.A. Alexander and *A. lentiginosus* var. *pseudiodanthus* (Barneby) J.A. Alexander form the western axis of the continuum with deciduous, mostly 180° curved, triquetrous, scarcely inflated pods and a septum from one-quarter to less than one-half the width of the locule. Barneby (1964) was the

first to recognize this similarity. In his uniquely succinct style, he stated "this pair of species [*A. iodanthus* and *A. pseudiodanthus*] posses no character which cannot be matched somewhere in *A. lentiginosus*" (p. 911) and "it is often difficult or nearly impossible to separate flowering material of [*A. iodanthus*] from the polymorphic *A. lentiginosus*, from which it differs principally in a tendency to dorsiventral and triquetrous compression of the fruit, which is never inflated and commonly very strongly incurved... however in *A. lentiginosus* var. *palans*, the lace-ellipsoid, little inflated pod varies from erect to decurved and its section varies from round to triangular, so that sometimes the only technical differential character that remains is the broader septum" (p. 959–960).

Other varieties of *A. iodanthus* have been recognized in Barnbey (1964), Isely (1998) and Welsh (2007), but they are treated herein and in Alexander (2008) as synonyms. Results of population level morphological analyses in progress may warrant recognition of *A. iodanthus* var. *diaphanoides* Barneby and *A. iodanthus* var. *vipereus* Barneby at the varietal-level within *A. lentiginosus*.

Astragalus lentiginosus var. **micans** Barneby, Leafl. W. Bot. 8:22. 1956. PROTOLOGUE: "CALIFORNIA: lower slopes of sand dunes at southeast end of Eureka Valley, east of Inyo Mts., Inyo County, elevation 3050 ft. May 13, 1955 (fr.) *John C. Roos 6354*, and at the same place, elevation 3100 Ft., April 9, 1955 (fl.), *Munz & Roos 20851*. Cotypes... Rancho Santa Ana Bot. Gard." TYPE: U.S.A. CALIFORNIA: Inyo Co.: lower slopes of sand dunes at SE end of Eureka Valley, E of Inyo Mts., 13 May 1955, *J.C. Roos 6354* (LECTOTYPE, designated here: RSA 100179!; ISOLECTOTYPES: GH!, K!, NY! [2 sheets], OSC!, RSA 114694!, SD, UC! [2 sheets], US 2483071, internet image!); U.S.A. CALIFORNIA: Inyo Co.: on sand dunes at S end of Eureka Valley, E of Inyo Mts., 9 Apr 1955, *P. Munz & J.C. Roos 20581* (EPITYPE, designated here: RSA 100180!; ISOEPITYPES: NY!, OSC!, RSA 109974!, RSA 115975!, UC!).

Notes.—Barneby (1956) designated two syntypes (as cotypes) in the protologue: one with fruit (*John C. Roos 6354* RSA) and one with flowers (*Munz & Roos 20581* RSA). He did not state the herbarium accession numbers in this publication. In his monograph, Barneby (1964) kept the same format, as cotypes, and did not designate a lectotype. Welsh (2007) also kept Barneby's format but listed both as syntypes. The fruiting specimen, *Roos 6354* (RSA100179) is designated here as the lectotype (McNeill et al. 2006, Article 9.2 and 9.10). Although there are some mostly withered flowers on the lectotype and the isolectotypes, the best floral characteristics are found on the flowering syntype. To keep all of the material used in the original type description (and the original intention of the author) intact, the flowering specimen *Munz & Roos 20581* (RSA100180) is selected here as the epitype (McNeill et al. 2006, Article 9.7).

It should be noted that in his original type publication, Barneby (1956) mistakenly cited "*Munz & Roos 20851*" as the syntype at RSA. Also Welsh (2007) mistakenly stated that the RSA syntype was "*Munz & Roos 20815*". All syntype specimens at RSA bear the correct collection number, *Munz & Roos 20581*. Also all isosyntypes at various institutions listed above are labeled with the collection number, *Munz & Roos 20581*. There do not appear to be any types with labels bearing the typographical errors published by Barneby or Welsh.

Astragalus lentiginosus var. **oropedii** Barneby, Leafl. W. Bot. 4:135. 1945. PROTOLOGUE: "Kaibab Trail to Roaring Springs, Grand Canyon National Park, Coconino County, Arizona, 22 September 1938, fruct., *Eastwood & Howell No. 7064* (Herb. Calif. Acad. Sci. No. 262056). Also ibid., 23 June 1933, flor., *Eastwood & Howell No. 1054* (Herb. Calif. Acad. Sci. No. 211208, COTYPE)." TYPE: U.S.A. ARIZONA: Coconino Co.: Kaibab Trail to Roaring Springs, 22 Sep 1938, *A. Eastwood & J.T. Howell 7064* (LECTOTYPE, designated by Barneby 1989:158: CAS 262056!); U.S.A. ARIZONA: Coconino Co.: Kaibab Trail to Roaring Springs, 23 Jun 1933, *A. Eastwood & J.T. Howell 1054* (EPITYPE, designated here: CAS 211208!)

Notes.—Barneby (1945) designated two syntypes (as cotypes) in the protologue: one with fruit (*Eastwood & Howell 7064*, CAS) and one with flowers (*Eastwood & Howell 1054,* CAS). In his monograph, Barneby (1964) kept the same format and did not designate a lectotype. For the Intermountain Flora, Barneby (1989) listed *Eastwood & Howell 7064* as the holotype for *A. lentiginosus* var. *oropedii* Barneby, which effectively is a lectotypification (McNeill et al 2006, Article 9.8). The flowers of *A. lentiginosus* var. *oropedii* are the most diagnostic feature, so an epitype is needed for precise taxonomic application of this variety. The epitype of *A. lentiginosus* var. *oropedii* is designated herein as the flowering specimen designated by Barneby as a syntype, *Eastwood & Howell 1054* (CAS; McNeill et al. 2006, Article 9.7), a designation that leaves intact the material used in Barneby's original description.

Astragalus lentiginosus var. **pseudiodanthus** (Barneby) J.A. Alexander, comb. nov. *Astragalus pseudiodanthus* Barneby, Leafl. W. Bot. 3:99. 1942. *Astragalus iodanthus* var. *pseudiodanthus* (Barneby) Isely, Syst. Bot. 8:422. 1983. PROTOLOGUE: "NEVADA: in deep sands of the plateau north of Cactus Peak, about twenty miles southeast of Tonopah, Nye Co.: alt. 5500 ft, 3 Jun 1941, *Ripley & Barneby No. 3725*." TYPE: U.S.A. NEVADA: Nye Co.: plateau N of Cactus Peak, about 20 mi SE of Tonopah, 3 Jun 1941, *H.D. Ripley, R.C. Barneby 3725* (HOLOTYPE: CAS 290405!; ISOTYPE: RSA, POM).

Notes.—For a more detailed discussion of the relationships between this taxon and *A. lentiginosus*, see the above treatment of *A. lentiginosus* var. *iodanthus*.

Barneby (1964) was the first to describe in detail of the degree of intergradation of *A. lentiginosus* var. *pseudiodanthus* and some populations of *A. lentiginosus* var. *iodanthus*. These intermediate populations are uncommon but spread throughout its range. It is likely that *A. lentiginosus* var. *pseudiodanthus* recently differentiated from several of these relictual, intermediate populations and became adapted to a stabilized sand dune habitat. Similar adaptations have occurred in populations of *A. lentiginosus* var. *variabilis* Barneby, *A. lentiginosus* var. *fremontii* (A. Gray ex Torr.) S. Watson and *A. lentiginosus* var. *stramineus* (Rydb.) Barneby (which may itself be a sand dune derivative of *A. lentiginosus* var. *fremontii* or *A. lentiginosus* var. *vitreus* Barneby).

Population level morphological analyses in progress, leading to an overall monograph of Section *Diphysi*, may provide more details on the taxonomic status of these sand dune variants.

ACKNOWLEDGMENTS

Numerous individuals provided advice, funding and encouragement during various stages of this project including: Wesley E. Niles; Aaron Liston; Richard Halse; Kathryn Birgy of the UNLV Herbarium; Arnold Tiehm and the Northern Nevada Native Plant Society (and the NNNPS Small Grants Program); Lisa Decesare of the Library of the Gray Herbarium, Harvard University; and the Moldenke Fund for Plant Systematics and the Hardman Fund at Oregon State University. Additional thanks go to the late R.C. Barneby and the Barneby Fund for Research in Legume Systematics, which funded a month of research at NY. The following herbaria's online databases were consulted for this project: CAS, DS, GH, JEPS, K, MO, NY, OSC, ORE, RSA, SD, UC, UCR, UCSB, UNLV, US, WILLU. I thank the curators and staff of the following herbaria for access to their collections or loans of their specimens: BRY, CAS, DS, GH, JEPS, K, NY, OSC, ORE, RENO, RM, RSA, UC, UNLV, US, WILLU. Arnold Tiehm and one anonymous reviewer provided useful reviews.

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